Claims

[c1]   A method to facilitate optimizing a winding and lamination configuration of an
electric machine uses a computer including a microprocessor for executing
computer functions, a database for storing optimization data, and a two-level
optimization algorithm having a first optimization module and a second
optimization module, said method comprises:
generating a plurality of data sets utilizing the first optimization module;
determining an optimum response surface based the data sets, utilizing the second
optimization module;
determining an optimum data set based on the optimum response surface,
the first optimization module; and
outputting an optimum winding and lamination configuration based on the
data set.

[c2]   A method in accordance with Claim 1 wherein generating a plurality of data sets
comprises generating a plurality of winding configurations utilizing at least one of
winding parameters and motor level variables stored in the database.

[c3]   A method in accordance with Claim 2 wherein determining an optimum response
surface comprises:
determining at least one lamination geometry for each winding configuration that
will combine with each winding configuration to satisfy a first set of performance
constraints;
outputting each lamination geometry to the database; and
determining an optimum geometry response surface that satisfies a second set of
performance constraints, based on the lamination geometries.

[c4]   A method in accordance with Claim 3 wherein determining an optimum data set
comprises computing an optimum winding solution based on the optimum
response surface and predetermined manufacturing objectives.

[c5]
A method in accordance with Claim 4 wherein outputting an optimum winding and
lamination configuration comprises:
outputting an optimum winding and lamination configuration based on the
winding solution, and

outputting cost and performance values corresponding to the optimum winding lamination configuration.

[c6]   A method in accordance with Claim 1 wherein generating a plurality of data sets comprises generating a plurality of lamination geometries that satisfy a first set of performance constraints, wherein the plurality of lamination geometries are from standard manufactured lamination geometries stored in the database.

[c7]   A method in accordance with Claim 6 wherein determining an optimum response surface comprises:
utilizing winding parameters and motor level variables stored in the database to determine at least one winding configuration for each generated lamination geometry that will combine with the lamination geometry to satisfy a second set of performance constraints;
outputting each winding configuration to the database; and
determining an optimum winding response surface.

[c8]   A method in accordance with Claim 7 wherein determining an optimum data set comprises computing an optimum lamination solution based on the optimum winding response surface and predetermined manufacturing objectives.

[c9]   A method in accordance with Claim 8 wherein outputting an optimum winding and lamination configuration comprises:
outputting an optimum winding and lamination configuration based on the lamination solution, and
outputting cost and performance values corresponding to the optimum winding lamination configuration.

[c10]   A system to facilitate optimizing a winding and lamination configuration of an electric machine, said system comprising a computer, said computer comprising:
a microprocessor for executing computer functions;
a database coupled to said microprocessor for storing data; and
a two-level optimization algorithm comprising a first optimization module and a second optimization module, said two-level optimization algorithm using data stored in said database and executed by said microprocessor.

[c11]   A system in accordance with Claim 10 wherein said first optimization module is a

winding optimization module, said computer programmed to utilize said winding optimization module to generate a plurality of winding configurations, said optimization module utilizing at least one of winding parameters and motor level variables stored in said database.

[c12]   A system in accordance with Claim 11 wherein said second optimization module is lamination optimization module, said computer further programmed to utilize said lamination optimization module to determine at least one lamination geometry for each winding configuration that will combine with the winding configuration to satisfy a first set of performance constraints.

[c13]   A system in accordance with Claim 12 wherein said computer further programmed utilize said lamination optimization module to generate an optimum geometry response surface based on the lamination geometry, the optimum geometry response surface satisfying a second set of performance constraints.

[c14]   A system in accordance with Claim 13 wherein said computer further programmed utilize said winding optimization module to generate an optimum winding solution based on the optimum geometry response surface and predetermined manufacturing objectives.

[c15]   A system in accordance with Claim 14 wherein said computer further programmed output an optimum winding and lamination configuration based on the optimum winding solution, and to output cost and performance values corresponding to the optimum winding and lamination configuration.

[c16]   A system in accordance with Claim 10 wherein said first optimization module is a lamination optimization module, said computer programmed to utilize said lamination optimization module to generate a plurality of lamination geometries satisfy a first set of performance constraints, the plurality of lamination geometries selected from standard manufactured lamination geometries stored in said

[c17]   A system in accordance with Claim 16 wherein said second optimization module is winding optimization module, said computer further configured to utilize winding parameters and motor level variables stored in said database to determine at least one winding configuration for each generated lamination geometry that will with the generated lamination geometry to satisfy a second set of performance

constraints.

[c18]   A system in accordance with Claim 17 wherein said computer further configured to utilize said winding optimization module to generate an optimum winding surface based on the winding configurations.

[c19]   A system in accordance with Claim 18 wherein said computer further configured to utilize said lamination optimization module to generate an optimum lamination solution based on the optimum winding response surface and predetermined manufacturing objectives.

[c20]   A system in accordance with Claim 19 wherein said computer further configured to output an optimum winding and lamination configuration based on the optimum lamination solution, and to output cost performance values corresponding to the optimum winding and lamination configuration.

[c21]   A two-level optimization algorithm to facilitate optimizing a winding and configuration of an electric machine comprising;
a first optimization module; and
a second optimization module;
wherein said first optimization module configured to generate a first optimization solution based on output from said second optimization module and said second optimization configured to generate a second optimization solution based on from said first optimization module, said two-level optimization algorithm configured to generate a global optimization solution based on the first and optimization solutions.

[c22]   An algorithm in accordance with Claim 21 wherein said first optimization module is a winding optimization module configured to generate a plurality of winding configurations utilizing at least one of winding parameters and motor level variable stored in a database.

[c23]   An algorithm in accordance with Claim 22 wherein said second optimization is a lamination optimization module configured to generate at least one lamination geometry for each winding configuration that will combine with the winding configuration to satisfy a first set of performance constraints.

[c24]   An algorithm in accordance with Claim 23 wherein said lamination optimization
            module further configured to generate an optimum geometry response surface
            based on the lamination geometry, the optimum geometry response surface
            satisfying a second set of performance constraints.

[c25]   An algorithm in accordance with Claim 24 wherein said winding optimization
            further configured to generate an optimum winding solution based on the
            geometry response surface and predetermined manufacturing objectives.

[c26]   An algorithm in accordance with Claim 25 wherein the global optimization solution
            is an optimum winding and lamination configuration based on the optimum
            solution, said two-level optimization algorithm further configured to output cost
            performance values corresponding to the optimum winding and lamination
            configuration.

[c27]   An algorithm in accordance with Claim 21 wherein said first optimization module is
            a lamination optimization module configured to generate a plurality of lamination
            geometries that satisfy a first set of performance constraints, the plurality of
            lamination geometries selected from standard manufactured lamination geometries
            stored in said database.

[c28]   An algorithm in accordance with Claim 27 wherein said second optimization
            is a winding optimization module configured to utilize winding parameters and
            motor level variables stored in a database to determine at least one winding
            configuration for each generated lamination geometry that will combine with the
            generated lamination geometry to satisfy a second set of performance constraints.

[c29]   An algorithm in accordance with Claim 28 wherein said winding optimization
            further configured to generate an optimum winding response surface based on the
            winding configurations.

[c30]   An algorithm in accordance with Claim 29 wherein said lamination optimization
            module further configured to generate an optimum lamination solution based on
            optimum winding response surface and predetermined manufacturing objectives.

[c31]
            An algorithm in accordance with Claim 30 wherein the global optimization solution
            is an optimum winding and lamination configuration based on the optimum

lamination solution, the two-level optimization solution further configured to cost performance values corresponding to the optimum winding and lamination configuration.